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STUDIES ON DECAPOD CRUSTACEA FROM THE INDIAN RIVER REGION OF FLORIDA. XIX. LARVAL DEVELOPMENT IN THE LABORATORY OF *LEPIDOPA RICHMONDI* BENEDICT, 1903, WITH NOTES ON LARVAE OF AMERICAN SPECIES IN THE GENUS (ANOMURA: ALBUNEIDAE)

Robert H. Gore and Cindy Lee Van Dover

Abstract.—The complete larval development of a sand crab species attributed to *Lepidopa richmondi* (based on morphological characters seen in the megalopal stage) is described and illustrated, using a first stage zoea obtained from the plankton and cultured in the laboratory. Three zoeal and one megalopal stage were obtained. Zoeal features are compared with those seen in two other western Atlantic and two eastern Pacific species. Data suggest that the zoeal stages may be segregated along the same lines of species groupings established for adults, with Atlantic zoeae differing in telsonal characters from those known in eastern Pacific larvae. This report is the first to describe the complete development for any Atlantic species in the laboratory.

The genus *Lepidopa,* commonly known as sand crabs, consists of small, filter-feeding intertidal and subtidal marine anomurans which have the carapace and pereopods modified for burying in the substratum. Five species occur in the western North Atlantic, 3 primarily in the Caribbean Sea, and 2 reaching continental waters of the United States. The complete larval development of these crustaceans remains unknown. Johnson and Lewis (1942) and Knight (1970) described larvae of an eastern Pacific species attributed to *Lepidopa myops* Stimpson, 1860 [since considered by Efford (1971) to be larvae of *L. californica*]. In the same paper, Knight described and illustrated the planktonic larvae of a second species she called *Lepidopa* species "B." In the Atlantic, the only description of *Lepidopa* larvae is that of Sandifer and Van Engel (1972) who described and illustrated 3 zoeal stages of a species obtained from Chesapeake Bay plankton, which they attributed to *L. websteri* Benedict 1903, because it was the only species known to reach Virginian coastal waters. The second continental species, *L. benedicti* Schmitt, 1935, occurs in the Gulf of Mexico and along the southeastern and central eastern Florida coastline (Holthuis, 1960; Efford, 1971; Gore, unpublished).

On 19 September 1972, a single albuneid zoeal stage I was collected from the plankton 2 miles east of Jupiter Inlet, Martin County. on the central eastern Florida coast. This specimen, originally maintained in the laboratory as a matter of curiosity, completed its zoeal development and attained megalopal stage, but unfortunately died without molting to crab stage I. Morphological features of the frontal margin of the carapace, the walking legs, third maxillipeds and second abdominal somite, were sufficiently developed in the megalopa to suggest that the species observed was *Lepidopa richmondi* Benedict, 1903 (see Discussion). In view of the limited amount of knowledge on larval development in the Albuneidae we provide herein a description of the zoeal and megalopal stages of what we believe to be *L. richmondi*. If our identification of the megalopa is correct, it indicates that larvae of *L. richmondi* occur in neritic waters along the eastern Floridan continental shelf, although adults have yet to be discovered there.

Materials and Methods

The single first zoeal stage was maintained in the laboratory in a glass finger bowl with 250 cc of seawater (35‰ salinity). Fresh *Artemia* nauplii and *Chlorella* sp. algae were provided and water was changed daily. Room temperature of about 24°C (±0.5°C) was obtained using closed circuit air-conditioning. Upon attaining megalopal stage the specimen was transferred to a 500 cc glass bowl containing sieved, autoclaved quartzite sand in hopes that crab stages could be obtained in order to positively identify the species. As noted, the specimen died before this occurred. The description that follows is based on the molted carapaces and dissected appendages of the zoeal stages, and the partial dissection of the megalopal stage. Methodology was identical to that used by Gore (1973).

Results and Discussion of the Rearing Experiment

When collected on 19 September 1972 the specimen was obviously in the first zoeal stage as determined by the fixed eyes, and the presence of 4 natatory setae on the maxillipeds. The second and third zoeal stages were attained on 22 and 28 September, followed by the megalopal stage on 6 October. Although the duration of the first zoeal stage is unknown (certainly at least 4 days, and probably 7–8 days if second stage duration can be used as an equivalent; see Knight, 1970), the overall developmental time in the plankton was at least 18 days based on molting occurrence in the laboratory. Examination of the megalopa which died in day 4 of that stage gave no indication of imminent molt, so that we may extrapolate a planktonic and postlarval duration of at least 3 weeks or so for the species at 24°C, before the first crab stage is attained.

This is substantially less time than the 45–53 days required for *L. cali-*

fornica to reach first crab (Knight, 1970). However, that species, and the larvae attributed to *L. websteri* by Sandifer and Van Engel (1972) possessed 4 zoeal stages, so that extended duration would be suspected. Unfortunately, because they were working with larvae obtained from the plankton, the latter authors provided no duration-in-stage data. It thus appears that *L. richmondi* differs from other known members of the genus in its developmental sequence, possessing 3 instead of 4 zoeal stages. This assumes, of course, that laboratory development in this species did not accelerate the zoeal sequences and cause a late stage to be skipped. In this respect, our third stage zoea resembled that figured by Sandifer and Van Engel in possessing well-formed uropods and six abdominal somites, but differed in having well-developed pleopod buds which were lacking in Sandifer and Van Engel's third stage zoea. Presence of pleopod buds usually indicates the molt to megalopa is imminent, although some species of galatheid zoeae may pass through one additional stage before reaching postlarvae (Gore, 1979).

If *L. richmondi* does pass through only 3 zoeal stages it might explain in part the relative distribution of the species which seems to be confined to the Caribbean Sea and southward to Brazil. Shortened zoeal development, perhaps larvae entrained in local current gyres, would tend to hold the species in a more limited geographic area. The species' farthest occurrence northward is the islands of Puerto Rico and Jamaica (Holthuis, 1960; Efford, 1971), and the single larva used in this study could have come from either locality.

Description of the Larvae

First zoea.—(Carapace length 1.6, rostral spine 4.6, posterior carapace spine 2.6 mm.)

Carapace (Fig. 1A, B): Smooth, somewhat inflated, ovoid; with elongate rostral and posterior carapace spines, former 2.9, latter 1.6× carapace length, all smooth, unarmed. No setae observed on carapace. Eyes unstalked.

Antennule (Fig. 1C): Flabellate rod, 3 aesthetascs, 1 seta.

Antenna (Fig. 1D): Protopodite a slender, dagger-like process armed on distal ¾ with rows of serrated teeth. Exopodite an elongate tapering process, 1.6× longer than protopodal spine, a single plumose seta medially. Basal segment with a single short spine distally at junction with exopodite. En-

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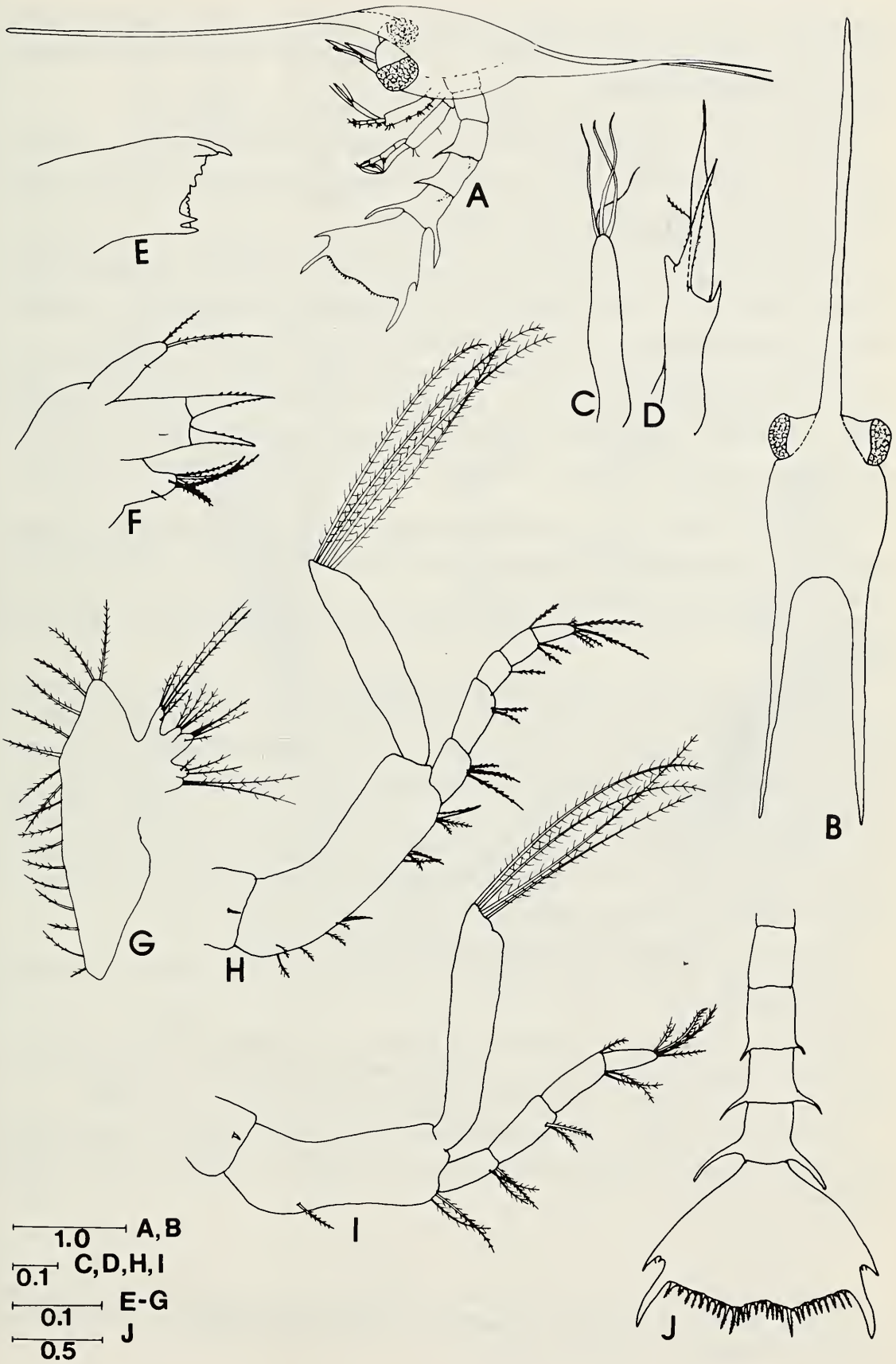
Fig. 1. *Lepidopa richmondi,* first zoea: **A,** Lateral view; **B,** Dorsal view; **C,** Antennule; **D,** Antenna; **E,** Mandible; **F,** Maxillule; **G,** Maxilla; **H,** Maxilliped 1; **I,** Maxilliped 2; **J,** Abdomen and telson. Scale lines in mm.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J

dopodite a short bud adjacent to protopodal spinous process. General form of antenna remains similar through subsequent stages, but relative proportions of processes change.

Mandible (Fig. 1E): Asymmetrical dentate processes, no palp.

Maxillule (Fig. 1F): Endopodite unsegmented, 2 terminal setae, a subterminal hair; basal endite with 2 strong spines plus a small hair laterally; coxal endite with 5 strong setae plus a lateral hair.

Maxilla (Fig. 1G): Endopodite unsegmented, 4 terminal, 1 subterminal seta (2 quite long); basal endite proximal and distal lobes each with 4 setae; coxal endite with 3 and 2 long setae on distal and proximal lobes, respectively; scaphognathite an elongate sublanceolate lobe with 17 setae.

Maxilliped 1 (Fig. 1H): Coxopodite with a single spinule; basipodite setal formula progressing distally 3, 3, 3, 3; distal triads each with heavy serrate seta as shown; endopodite 5-segmented, setal formula 3, 2, 1, 2 + I, 5; exopodite a single segment, 4 natatory setae. (Note: Roman numeral denotes dorsal seta.)

Maxilliped 2 (Fig. 1I): Coxopodite with a single spinule; basipodite setal formula 1, 2; endopodite 4-segmented, setal formula 3, 2, 2 + I, 5; exopodite single segment with 4 natatory setae.

Maxilliped 3 and pereopod buds: Present but too diaphanous to illustrate from molt.

Abdomen and telson (Fig. 1J): Five somites, third to fifth with posterolateral spines increasing in size toward telson; latter a roundly spatulate process, with two pairs lateral spines, distal 3× length of proximal, former with a small spine plus thin anomuran hair in axil; telson width 1.8× length, posterior margin with 29 spines of varying length, ninth or ninth and tenth from exterior noticeably longer than others; no dorsal or ventral setae noted on telsonal surface. In the terminology used by Gore (1979) for this type of telson, the setal formula reads: I + ii + 3 + IV + 5–18.

Color: Not noted; no chromatophores visible in molts.

Second zoea.—(Carapace length 1.9; rostral spine 5.7; posterior carapace spine 2.6 mm.)

Carapace (Fig. 2A, B): Similar to stage I, but larger; rostral spine 3×, posterior carapace spine 1.4×, carapace length, all smooth, unarmed. Carapace now with small anterolateral spinule subocularly; eyes mobile.

Antennule (Fig. 2C): Two-segmented, distal with 1 apical, 2 subapical, 2 lateral aesthetascs; 1 thin apical, 2 basal setae, latter at junction of proximal segment as shown.

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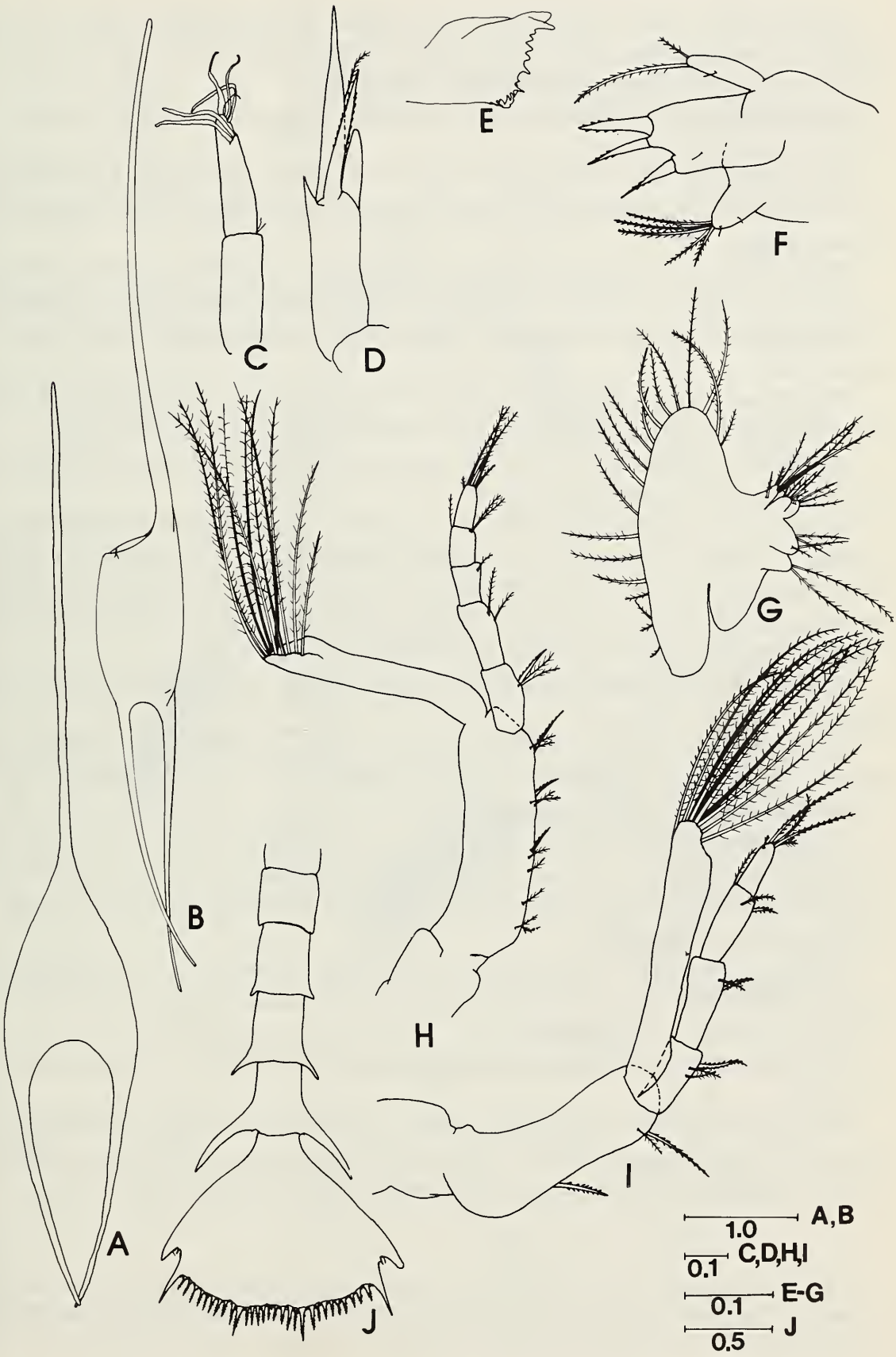
Fig. 2. *Lepidopa richmondi,* second zoea: **A,** Dorsal view; **B,** Dorsolateral view; **C,** Antennule; **D,** Antenna; **E,** Mandible; **F,** Maxillule; **G,** Maxilla; **H,** Maxilliped 1; **I,** Maxilliped 2; **J,** Abdomen and telson. Scale lines in mm.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C,D,H,I
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J

Antenna (Fig. 2D): Exopodite 1.6× length of protopodal spine, 3.1× length of endopodite; latter about half length of protopodal spine; basal spine at junction of exopodite slightly larger.

Mandible (Fig. 2E): Relatively unchanged from stage I, teeth sharper, more numerous.

Maxillule (Fig. 2F): Endopodite and coxal endite unchanged from stage I, except latter with additional fine seta laterally; basal endite with additional strong spine.

Maxilla (Fig. 2G): Endopodite with 5 terminal, 1 subterminal setae; basal endite unchanged from first stage; coxal endite distal lobe with 3 terminal, 1 subterminal setae; proximal lobe unchanged; scaphognathite with 19 marginal setae.

Maxilliped 1 (Fig. 2H): Coxopodite without spinule; basipodite and endopodite unchanged from first stage; exopodite with 10 natatory setae.

Maxilliped 2 (Fig. 2I): As in first stage, now lacking coxopodal spinule; exopodite with 10 natatory setae.

Abdomen and telson (Fig. 2J): Five somites, configuration and armature similar to stage I, but spine on somite 3 reduced; telson process formula remains I + ii + 3 + IV + 5–18; movable spines 9–10 larger than preceding or succeeding spines; a reduced median spinule present; telson otherwise without surface setae, its width 1.4× length.

Third zoea.—(Carapace length 2.9; rostral spine 7.7; posterior spine 4.2 mm.)

Carapace (Fig. 3A, B): Similar to previous stage but larger, more inflated; rostral spine 2.7×, posterior carapace spine 1.4×, carapace length, unarmed. Anterolateral spinule larger.

Antennule (Fig. 3C): Distal segment more elongate relative to proximal, bearing 7 aesthetascs, 3 setae progressing distally as 2, 2, 2, 1 + 3 setae; 2 small, 2 larger thin setae at junction of proximal and distal segments; former with single seta medially.

Antenna (Fig. 3D): Exopodite 1.8× protopodal spine, 2.0× endopodite length, latter just slightly shorter than protopodal spine; basal spine at junction of exopodite unchanged.

Mandibles (Fig. 3E): Becoming distinctly scoop-shaped, with larger teeth; no palp.

Maxillule (Fig. 3F): Endopodite with 3 terminal setae plus usual subterminal hair; basal endite with 4 strong spines plus lateral seta; coxal endite with 5 terminal, 1 subterminal, and 2 lateral setae as illustrated.

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Fig. 3. *Lepidopa richmondi*, third zoea: **A**, Lateral view; **B**, Dorsal view; **C**, Antennule; **D**, Antenna; **E**, Mandibles; **F**, Maxillule; **G**, Maxilla; **H**, Maxilliped 1; **I**, Maxilliped 2; **J**, Maxilliped 3 and pereopods; **K**, Abdomen and telson; **L**, Detail, telsonal lateral spines. Scale lines in mm.


A
B
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D
E
F
G
H
I
J
K
L
1.0 A
1.0 B
0.1 C,D,H,I
0.1 E,F,G,L
0.5 J
0.5 K

Maxilla (Fig. 3G): Endopodite setae unchanged from previous stage, now noticeably separated into lobes, progressing apically as 1 + 3 + 2; basal endite proximal lobe with additional strong seta, all other lobes unchanged; scaphognathite with 41 marginal setae.

Maxilliped 1 and 2 (Fig. 3H, I): Unchanged except for exopodites, bearing 14 and 13 natatory setae, respectively; serrate basal spines quite noticeable.

Maxilliped 3 and pereopods (Fig. 3J): Undivided and amorphous buds, latter without evidence of chelation or segmentation.

Abdomen and telson (Fig. 3K, L): Now with 6 somites, spine on somite 3 absent; pleopod buds on somites 2–5; somite 6 with uniramous, two-segmented setose uropods; telson 1.5× wider than long, with 5 pairs of thin setae in longitudinal row dorsally; posterior marginal formula I + ii + 3 + IV + 5–19, ninth process noticeably larger than adjacent movable spines; under high magnification (20×) a series of very small spinules interspersed among all processes (Fig. 3L).

Megalopa.—(Carapace length × width 3.0 × 2.5 mm.)

Carapace (Fig. 4A, B): Dorsoventrally depressed, subrectangular, more or less smooth, areas poorly delineated, marginally setose from anterolateral to branchial regions; anterolateral and outer orbital spines distinct; rostral spine thin, elongate, reaching distal margin of second antennal segment; orbits deeply excavate, concave, with marginal setae; remnants of posterior carapacial spines on posterolateral margin of carapace; a transverse row of fine hairs on frontal region, a similar but shorter row on cardiac area.

Abdomen (Fig. 4C): Six somites, 2–5 with expanded, setose pleura, decreasing in size distally; paired biramous pleopods on somites 2 (Fig. 5K) through 5 (Fig. 5L), *appendices internae* on endopodites of 3, 4, 5, and varying numbers of setae present; exopodites becoming more setose progressing toward telson. Somite 6 with biramous uropods, setose as illustrated, but protopodite naked (Fig. 5M).

Telson (Fig. 4C): Width 1.4× length; subcircular, bearing remnants of larger lateral spines of zoeal telson, plus marginal setae as shown; dorsal longitudinal row of 5 pairs of thin setae still present, additional transverse and grouped setae along anterior and anterolateral margin as illustrated.

Antennule (Fig. 5A, B): Peduncle 3-segmented, a minute palp-like ventral flagellum, an elongate 24-segmented setose dorsal flagellum, latter with aesthetascs on terminal 3 segments, placed as shown in detail (Fig. 5B); other setae as illustrated.

Antenna (Fig. 5C): Three-segmented, enlarged peduncle, basal segment with lamellar setose lobe; third with short proximally setose scaphocerite, a longer 9-segmented dorsal flagellum; fourth segment from tip with 2 small palp-like processes.

Mandible (Fig. 5D): Marginally dentate scoop-shaped process; an en-

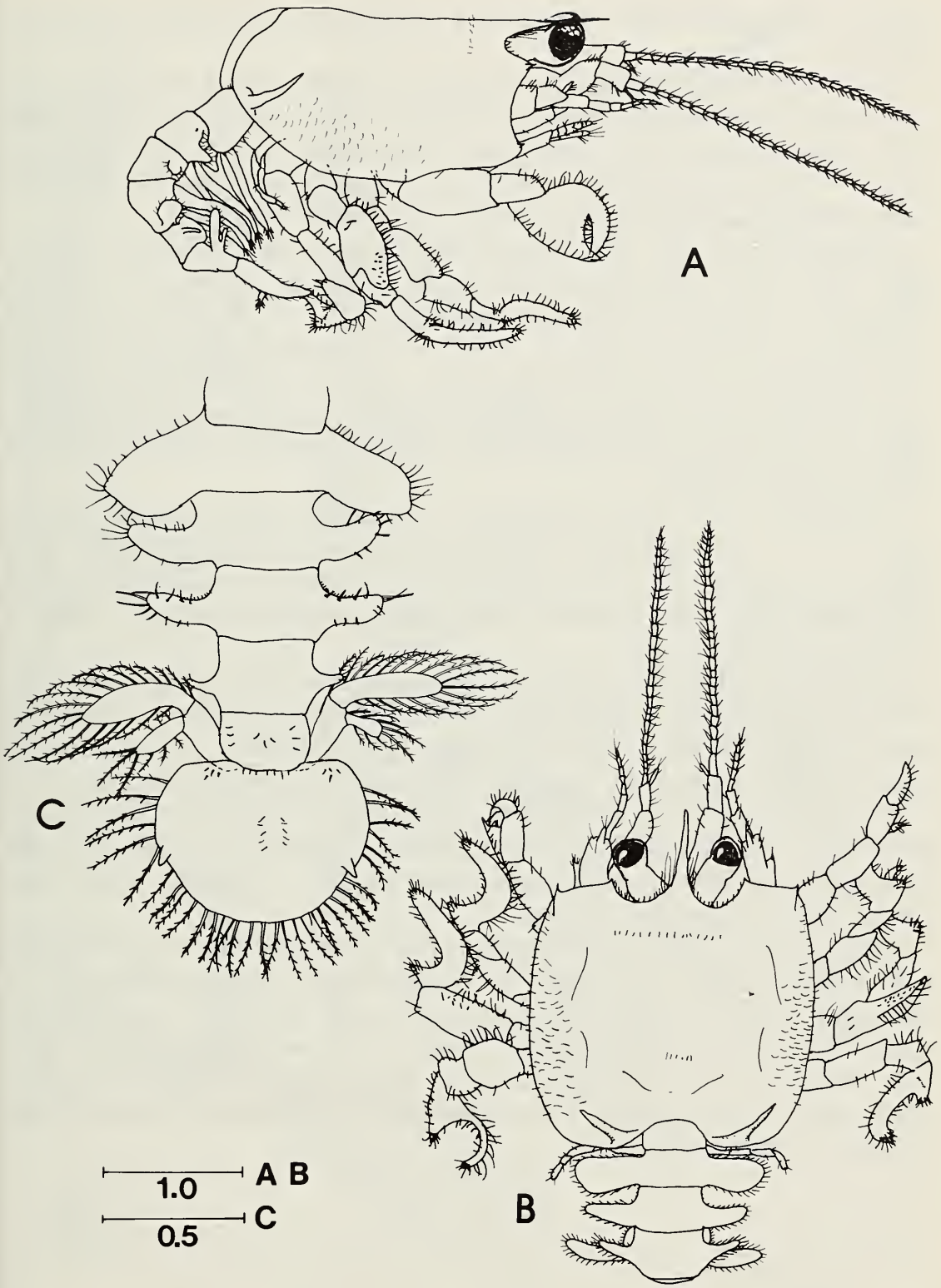

Fig. 4. *Lepidopa richmondi,* megalopa: **A,** Lateral view; **B,** Dorsal view; **C,** Abdominal somites and tail fan. Scale lines in mm.

larged 3-segmented palp, armed with strong setae and sharp spines as shown.

Maxillule (Fig. 5E): Endopodite elongate, basally inflated, folded back on itself distally, a single seta from protuberance on proximal lobe; basal endite with 15 strong spines and setae plus a thin seta laterally; coxal endite 12 apical, 2 lateral strong spines and setae; protopodal lobe basally with short sharp spine, an elongate plumose seta, plus a short stout seta.

Maxilla (Fig. 5F, G): Endopodite distally naked, with 3 minute setae basally; basal and coxal endites with varying number of setae, not exactly determined because of fragility, appearing as 11 + 1, 5 + 1 on distal and proximal lobes of former, 3 + 1, 3 + 2? + 2? on respective lobes of latter; what appears to be either a foreshortened epipod, or modified arthrobranch bud present on basal lobe; a second, rectangular setose lobe apparent proximally; scaphognathite with 101 marginal setae in addition to scattered short hairs on lateral surface.

Maxilliped 1 (Fig. 5H): Endopodite 5 segmented, setae progressing distally 3, 1, 1, 1, 0; exopodite 2-segmented, distalmost flattened, ovoid, with plumose marginal setae; protopodite with expanded, setose and spinose distal basal lobe, plus somewhat amorphous coxal lobe bearing 2 setae; a recurved epipod present.

Maxilliped 2 (Fig. 5I): Endopodite 5-segmented, setose and spinose as illustrated; exopodite 2-segmented, proximal segment about 4× length of distal, with 4 long setae from distomedial lobe of former, 7 plumose apical setae on latter; protopodite sparsely setose, with rudimentary epipod.

Maxilliped 3 (Fig. 5J): Endopodite 5-segmented, clothed with long bristle-like setae; antepenultimate segment developed distally into rounded lobe reaching about half length of penultimate segment; exopodite weakly calcified, naked; no epipod observed.

Pereopods (Fig. 6A–G): Pereopod 1 chelate, heavily setose; chela height 0.8× length, carpus 1.6×, merus 2.1× longer than wide; pereopods 2–5 as illustrated, merus of third with plumose seta plus scattered small spinules, carpus with longer spine-like setae; dactyls of all walking legs variably falcate; fifth pereopod indistinctly chelate, armed apically with several short sharp teeth, plus long setae, entire appendage considerably reduced in size relative to other pereopods.

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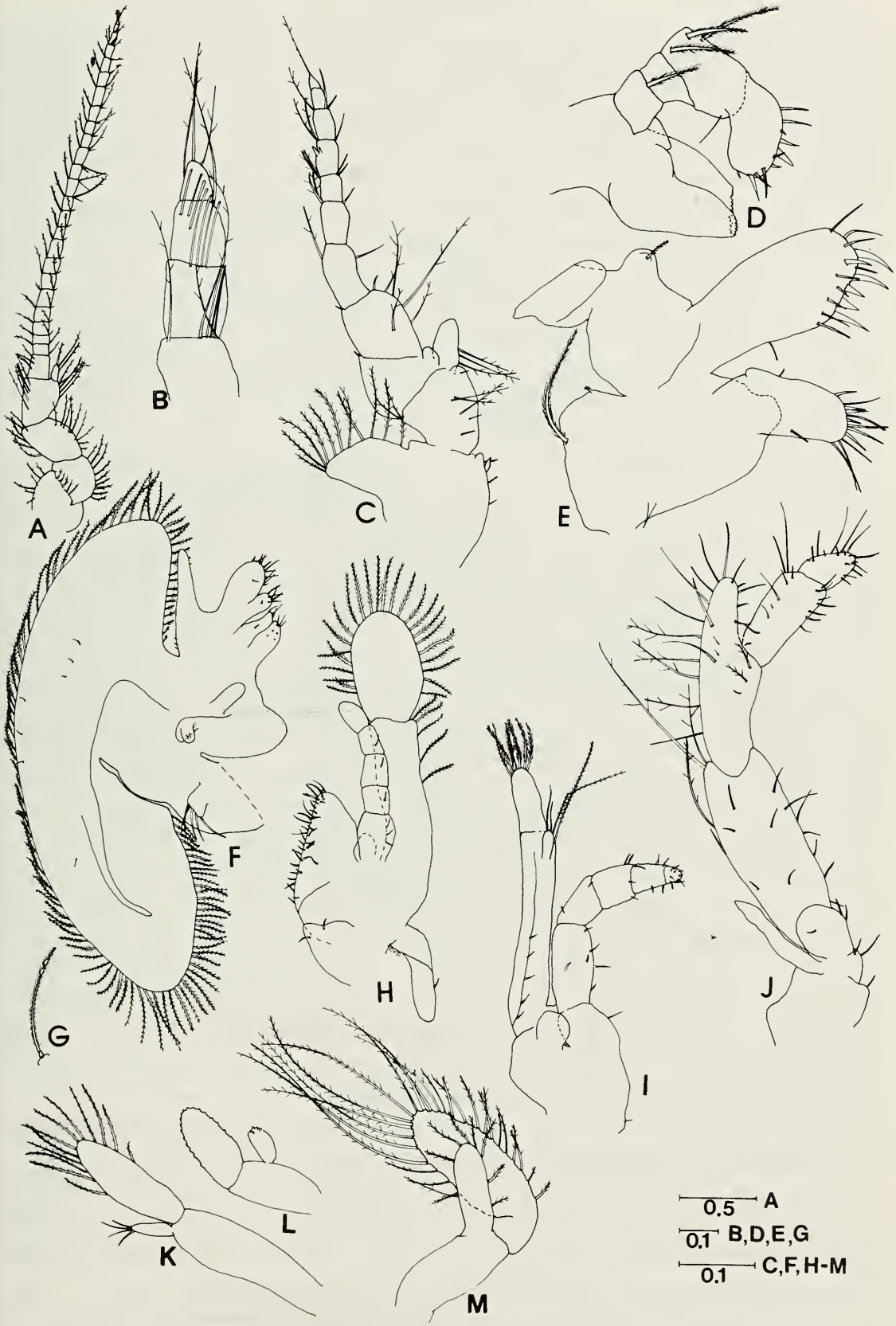
Fig. 5. *Lepidopa richmondi,* megalopa: **A,** Antennule; **B,** Detail, terminal segments of antennule; **C,** Antenna; **D,** Mandible; **E,** Maxillule; **F,** Maxilla; **G,** Maxilla, detail of scaphognathite seta; **H,** Maxilliped 1; **I,** Maxilliped 2; **J,** Maxilliped 3; **K,** Pleopod, somite 2; **L,** Pleopod, somite 5; **M,** Uropod, somite 6. Scale lines in mm.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0.5 A
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0.1 C,F,H-M

Discussion

The zoeal larvae of the Albuneidae are quite as distinctive as those of the Porcellanidae, another anomuran family, to which they show obvious morphological relationships. Larvae in both families possess elongate rostral and paired posterior carapacial spines. However, albuneid larvae and particularly those assigned to the genus *Lepidopa* are quickly distinguished from porcellanid zoeae by the possession of an extremely wide roundly or triangularly spatuliform telson, often armed with 2 pairs (instead of one pair) of fixed lateral spines. In addition, the posterior margin of the telson is heavily spinulose, a feature reminiscent of galatheid larvae (also Anomura) in the genus *Munidopsis* (see Samuelsen, 1972; Gore, 1979). *Lepidopa* larvae are further distinguished by having paired, elongate, often recurved spines on the posterolateral margin of the fifth abdominal somite (Knight, 1970), these being absent or reduced in porcellanids.

As presently delineated by Knight (1970) the larvae of *Lepidopa* may be separated from those of *Albunea* most easily by the telson (2 pairs lateral spines, i.e. processes I and IV fixed and enlarged in *Lepidopa*; 1 lateral pair, i.e. only process I fixed in *Albunea*); rostral and posterior carapacial spines greatly lengthened in *Lepidopa,* relatively short in *Albunea*; and the antennal scaphocerite more spine-like in *Lepidopa,* but more blade-like in *Albunea*. Based on these characters, the larvae illustrated by Gurney (1942) as Species A, that identified by Menon (1937) as *Albunea symmista,* and the telson figured by Gurney (1924) can all be considered as *Albunea*. In fact, if Species A is an *Albunea,* and if Gurney's statement is correct that only *Albunea oxyophthalma* [=*A. paretii* fide Monod, 1956] occurs in Bermuda, then Gurney's (1942) larva is a first zoea of *A. paretii* Guerin, 1853.

In the genus *Lepidopa,* larvae from the eastern Pacific (*L. californica* and *L.* species B) possess triangularly spatuliform telsons (see Johnson and Lewis, 1942, pl. 5, fig. 5; Knight, 1970, figs. 40–43, 61–64), whereas those from the Atlantic (see Gurney, 1942, fig. 110A–D; Sandifer and Van Engel, 1972, figs. 1B–3B; and this study) have a more roundly trigonal telson. Efford (1971) in reviewing the American species of *Lepidopa* diagnosed 3 groupings, viz. a *myops* group (including *L. californica*), a *benedicti* group (which contains *L. richmondi*), and a *venusta* group to which *L. websteri* belongs. Presently available data are admittedly scanty, but offer the possibility that larvae in the *myops* grouping may be distinguishable from those of the remaining two groups on telsonal characters alone. If the larvae of *L. websteri* and *L. richmondi* are correctly assigned, then both the *benedicti* and *venusta* group larvae may exhibit similar telsonal characters, i.e. roundly and broadly trigonal, as opposed to more narrowly and triangularly spatuliform telsons seen in known larvae of the *myops* group.

The first zoeal larvae of *Lepidopa* species B [as *Albunea* sp. B] illustrated by Gurney (1942) provides some support for this hypothesis. Although sim-

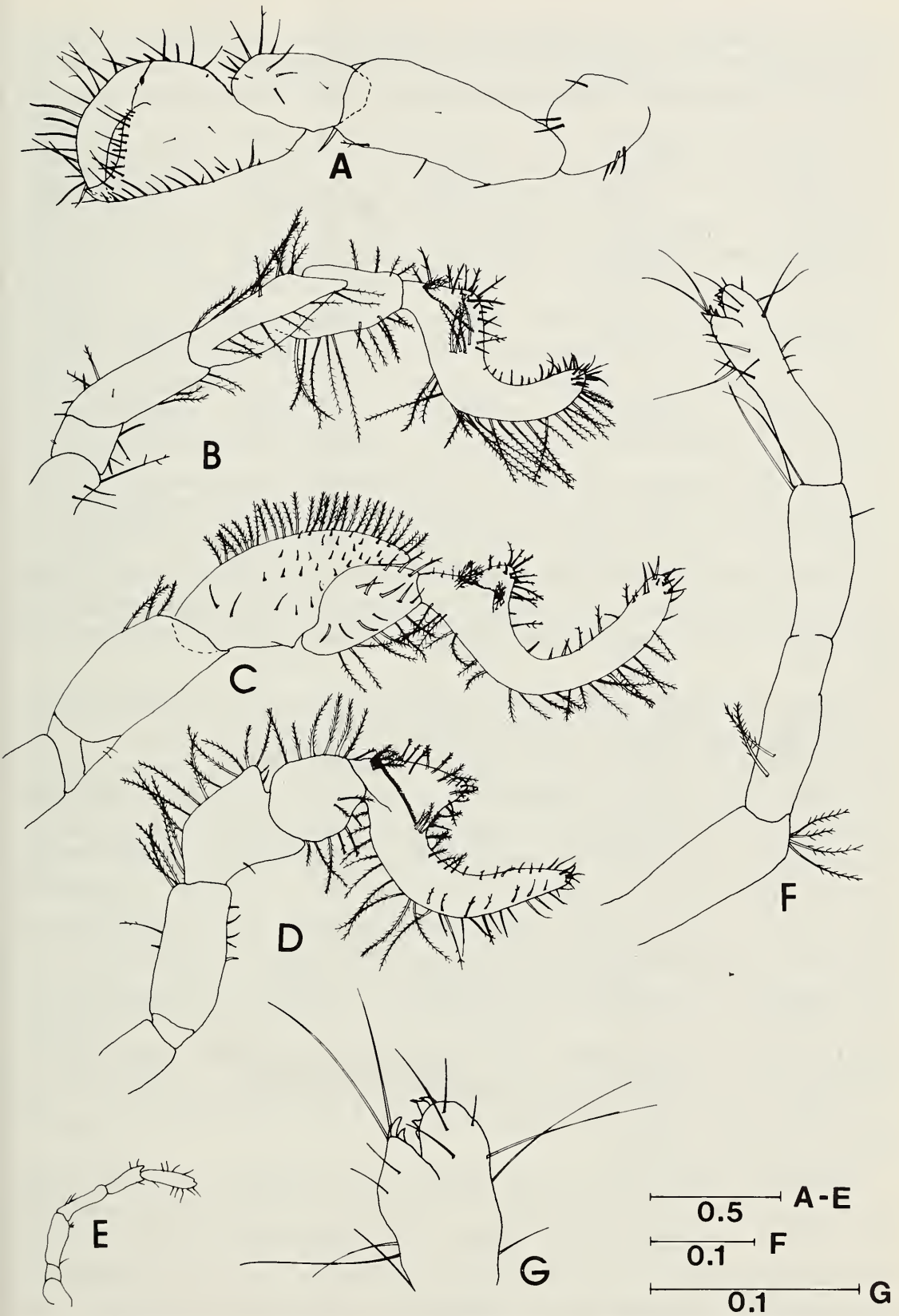

Fig. 6. *Lepidopa richmondi*, megalopa: **A**, Pereopod 1; **B**, Pereopod 2; **C**, Pereopod 3; **D**, Pereopod 4; **E**, Pereopod 5; **F**, Pereopod 5, detail of distal segments; **G**, Pereopod 5, Detail of cheliform segment. Scale lines in mm.

ilar in most features to first zoeae of *L. websteri* and *L. richmondi,* Gurney's larva is immediately distinguishable by having 3 setae on the antennal exopodite (scaphocerite), whereas the larvae of the 2 other species have but 1 seta there. Inasmuch as only 5 species of *Lepidopa* are presently known from the western Atlantic, with larvae of 2 species more or less completely described, Gurney's larva would presently be assignable to either *Lepidopa benedicti, L. venusta,* or *L. distincta.* The first species is known in the Gulf of Mexico from Vera Cruz to western Florida, and in the Atlantic along the Floridan east coast (Efford, 1971; Gore, unpublished) and thus seems the most likely candidate for Gurney's larva. Although the remaining 2 species are not yet known from continental waters of the United States, both are widely distributed throughout the eastern Caribbean and along the eastern coast of South America. While neither *L. venusta* nor *L. distincta* can be completely excluded from consideration, especially because their larvae might possibly become entrained in Antillean/Gulf Stream currents (as apparently do larvae of *L. richmondi*), and thus be carried to Florida or even Bermuda, we can provisionally eliminate *L. distincta* because it belongs to the *myops* group and its larvae may exhibit the triangularly spatulate telson of larvae known from that group. But until more data become available on the species the assignment to groupings remains conjectural for the most part.

In order to provide a comparison among the known larvae of *Lepidopa,* the salient morphological features of the 4 well-described species are presented in Table 1. All that can be said for Gurney's (1942) *Lepidopa* species B is that it shows some similarities to *L. websteri* in maxillary and maxillipedal setation, but differs most noticeably in the scaphocerite of the antenna having 3, instead of 1, marginal setae. In this respect it differs from all known first zoeae in the genus. As can be seen in the Table, maxillipedal setal formulae and antennal endopodite:protopodal spine lengths provide the easiest distinction among the larvae. Other features of some value, but requiring dissection, include maxillulary and maxillary setation, mandibular palp budding, and presence or absence of a coxopodal spine on the maxillipeds. Pleopodal buds appear in stage III of *L. richmondi* (which has no stage IV), but not until the subsequent stage in the other species. Except for the telsonal configuration previously noted, the species are more or less similar in many respects.

Megalopal comparisons are of limited value at present. The only megalopal stages available are those for *L. californica* and the single specimen in our study. A comparison of Knight's (1970) illustration with ours shows the differences between the 2 species most clearly, but morphological features such as setal formulae may eventually prove to be of value when more species become known.

We made specific identification for our study using the following char-

Table 1.—Comparison of selected morphological characters in *Lepidopa* zoeal stages.

	*L. californica**	*L.* sp. B	*L. websteri*	*L. richmondi*
ZOEA I				
Carapace length	1.2 mm	1.3 mm	ca. 1.0 mm	1.6 mm
Rostral spine	2.4× cl	2.6× cl	2–3× cl	2.9× cl
Dorsal margin	2 medial knobs	No data	Smooth	Smooth
Antennule	3 aesthetascs 3 setae	3 aesthetascs 3 setae	3 aesthetascs 1–3 setae	3 aesthetascs 1 seta
Antenna				
Endopodite	Absent	Absent	Absent	Short bud
Maxilliped 1				
Coxopodite	Unarmed	Unarmed	Unarmed	1 spine
Endopodite	3, 2, 1, 2, 5	3, 2, 1, 2, 5	3, 2, 1, 2, 5	3, 2, 1, 2+I, 5
Maxilliped 2				
Coxopodite	Unarmed	Unarmed	Unarmed	1 spine
Endopodite	3, 2, 2, 5	3, 2, 2, 5	3, 2, 2, 5	3, 2, 2+I, 5
Pereopods	Small buds	Small buds	Minute buds	Not seen
Abdomen	Dorsal setae +	Dorsal setae +	No setae	No setae
Lateral spine	3rd pair curved at tips	3rd pair curved at tips	3rd pair curved at tips	3rd pair straight at tips
Telson formula	I + ii + 3 + IV + 5–10 (to 13)	I + ii + 3 + IV + 5–12 (to 15)	I + ii + 3 + IV + 5–14 (to 16)	I + ii + 3 + IV + 5–18
ZOEA II				
Carapace length	1.4 mm	1.5 mm	ca. 1.9 mm	1.9 mm
Rostral spine	3× cl	3.3× cl	No data	3× cl
Antennule				
Aesthetasc-setal formula	2, 2, 1 + 3 setae	2, 2, 1 + 3 setae	2, 2, 1, + 3 setae	2, 2, 1, +1 seta
Basal segment	2 setae	2 setae	0–1 setae	2 setae
Antenna				
Endopodite	"Distinct bud"	Similar	"Small bud"	⅓ Exopodite length
Maxillule				
Coxal endite	5–6 setae	Similar	6 setae	7 setae
Maxilla				
Scaphognathite	13–18 setae	13–20 setae	20–23 setae	19 setae
Maxilliped 1				
Coxopodite	Unarmed	Unarmed	Unarmed	Unarmed
Endopodite	3, 2, 1, 2, 5	Similar	3, 2, 1, 3+I, 5	3, 2, 1, 2+I, 5
Exopodite	8 natatory	9–10 natatory	10 natatory	10 natatory

Table 1.—Continued.

	*L. californica**	*L.* sp. B	*L. websteri*	*L. richmondi*
Maxilliped 2				
Coxopodite	Unarmed	Unarmed	Unarmed	Unarmed
Endopodite	3, 2, 2, 5	Similar	3, 2, 2+I, 5	3, 2, 2+I, 5
Exopodite	8 natatory	Similar	10 natatory	10 natatory
Abdomen	No change	No change	No change	Somite 3 spine reduced
Uropods	Not apparent	Similar	Anlage visible	Not apparent
Telson formula	I + ii + 3 + IV + 5–15 (to 18)	I + ii + 3 + IV + 5–17 (to 19)	I + ii + 3 + IV + 5–14 (to 16)	I + ii + 3 + IV + 5–18
ZOEA III				
Carapace length	1.8 mm	1.8 mm	ca. 2.0 mm	2.9 mm
Rostral spine	3× cl	3.2× cl	No data	2.9× cl
Antennule				
Prox./dist. jct.	2 seta	Similar	None?	4 setae
Antenna				
Endopodite	ca. 0.5× protopodal spine	Similar	"Nearly as long" as protopodite	0.9× protopodal spine
Mandible	Small palp bud	Similar	No palp	No palp
Maxillule				
Endopodite	2 + 1 setae	Similar	2 + 1 setae	3 + 1 setae
Basal endite	3–4 spines, 1 seta	Similar	3 spines, 1 seta	4 spines, 1 seta
Maxilla				
Basal endite	4, 4 setae	4–5, 4–5 setae	4, 4 setae	4, 5 setae
Coxal endite	2, 2 setae	2–4, 2 setae	3, 2 setae	4, 2 setae
Scaphognathite	13–18 setae	26–33 setae	33–36 setae	41 setae
Maxilliped 1				
Endopodite	3, 2, 1, 2, 5	3, 2, 1, 2+I, 5	3, 2, 1, 3+I, 5	3, 2, 1, 2+I, 5
Exopodite	10–11 natatory	11–13 natatory	13–14 natatory	14 natatory
Maxilliped 2				
Endopodite	3, 2, 2+I, 5	Similar	3, 2, 3+I, 5	3, 2, 2+I, 5
Exopodite	10–11 natatory	12–13 natatory	13–14 natatory	13 natatory
Pereopods	P_1 cheliform	No data	P_1 cheliform	P_1 undivided
Abdomen	Somite 3 spine −	Similar?	Somite 3 spine +	Somite 3 spine −
Pleopods	Absent	Similar?	Absent	Buds, somites 2–5

Table 1.—Continued.

	*L. californica**	*L.* sp. B	*L. websteri*	*L. richmondi*
Uropod	Endopod bud +	Similar?	Endopod bud +	No bud observed
Telson formula	Unchanged from previous stage in all species			

* As *L. myops* in Knight, 1970.

acters in the megalopa: fifth abdominal somite with pleural expansion separates *Lepidopa* from *Albunea, Zygopa,* and *Stemonopa* (the latter is not yet known from the western Atlantic); carpus of maxilliped 3 not longer than propodus eliminates the *myops* group of species; absence of subrostral spine eliminates *venusta* grouping; a distinct rostrum, deeply concave orbital margins, abdominal somite 2 truncately rectangular and not directed posteriorly, and the shape of dactylii on pereopods 2, 3, 4, all suggest *L. richmondi* (Efford, 1971, especially figs. 6, 7), and not *L. benedicti.* Regrettably, the groove around the posterior margin of the carapace, an important diagnostic character in adults (and presumably megalopae) of the species, was undeveloped in our specimen. We also feel certain that we were not dealing with *L. websteri* because features in larvae of that species differ from those seen in ours (see Sandifer and Van Engel, 1972; Table 1, this study). Even though the distributional range of *L. benedicti* encompasses the central eastern Florida coast where our first zoeal stage was originally collected (suggesting it was that species) the Caribbean range of *L. richmondi* could easily allow larvae of this species to be entrained in the Florida Current and swept along the Atlantic coast of Florida.

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